ATTACHMENT A: Scope of Work

PROJECT NAME:

Spokane Valley-Rathdrum Prairie Aquifer Storage and Recovery for Summer Flow Augmentation of the Columbia River

PROJECT LOCATION:

Spokane Valley-Rathdrum Prairie aquifer - Spokane, Washington region

STREAM REACH MILE/ LOCATION:

The entire Spokane River and downstream through the Columbia River

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ABSTRACT:

Future development along the Columbia River requires innovative strategies for storing water during peak flow periods for use in low flow periods. Interactions between surface water and groundwater are of growing importance as the effects of increased groundwater withdrawals on stream flows during critical low-flow periods are becoming more pronounced. Conjunctive management of both sources requires sophisticated spatial and temporal analysis. In situations involving multiple jurisdictions such as state boundaries, management problems are magnified due to often conflicting regulations and policies. A transient MODFLOW model of the Spokane Valley-Rathdrum Prairie (SVRP) aquifer/river system mutually accepted by both the States of Idaho and Washington will be used in this study to evaluate solutions to potential water shortages through the use of strategically placed infiltration basins or injection wells. Artificial recharge of the SVRP aquifer will be simulated using diversions from Lake Pend Oreille, Lake Coeur d'Alene, the Spokane River, and a well field near the Spokane River during winter periods when flows are high and excess water is potentially available. Alternative locations for potential wells and detention basins will be examined. Lag times for the water to impact stream/groundwater interaction areas along the Spokane River will be evaluated to assess the potential for augmenting stream flows from July through September for diversion and use downstream in the Columbia River watershed. Preliminary results indicated that the aquifer could be used to improve low-flow season streamflow values utilizing both infiltration basins and injection wells with winter surface water diversions. Depending on the location, as much as 30% of the winter diversion rate could be lagged to improve summer flows at the Spokane gage. Thus, a regional mitigation strategy is likely scientifically feasible. However, a thorough analysis of potential locations will be conducted in this study. Furthermore, economic considerations need to be factored into any potential solution. This study will determine and evaluate the costs associated with pumping, piping, treating, distributing water throughout the watershed as part of an overall assessment of project feasibility.

Spokane Valley-Rathdrum Prairie Aquifer Storage and Recovery for Summer Flow Augmentation of the Columbia River

INTRODUCTION

As illustrated in Figure 1, the Spokane River watershed is located in eastern Washington and northern Idaho and is a tributary of the Columbia River upstream of Grand Coulee Dam. The 830 square kilometer (320 mi^2) Spokane Valley-Rathdrum Prairie (SVRP) aquifer lies within this sub-watershed. Because it is well connected to the Spokane River, it is believed that the SVRP represents a tremendous opportunity for aquifer storage and recovery. Preliminary studies conducted by the State of Washington Water Research Center using the bi-state aquifer model developed for Ecology and IDWR indicate that strategic location of infiltration and/or injection wells can act to significantly increase summer flows in the river. Because these flows are upstream of potential diversion locations for the Columbia Basin, increased river flows could be used to mitigate additional low-flow withdrawals. However, more work needs to be done in order to determine the best configuration of recharge facilities and the associated trade-offs between cost and yield. This project proposes to determine the feasibility of diverting high stream discharges during winter and high flow months when water is generally available and storing it in the Spokane Valley Rathdrum Prairie (SVRP) aquifer where it would naturally flow into the Spokane River throughout low-flow periods thus augmenting downstream Columbia River diversions.

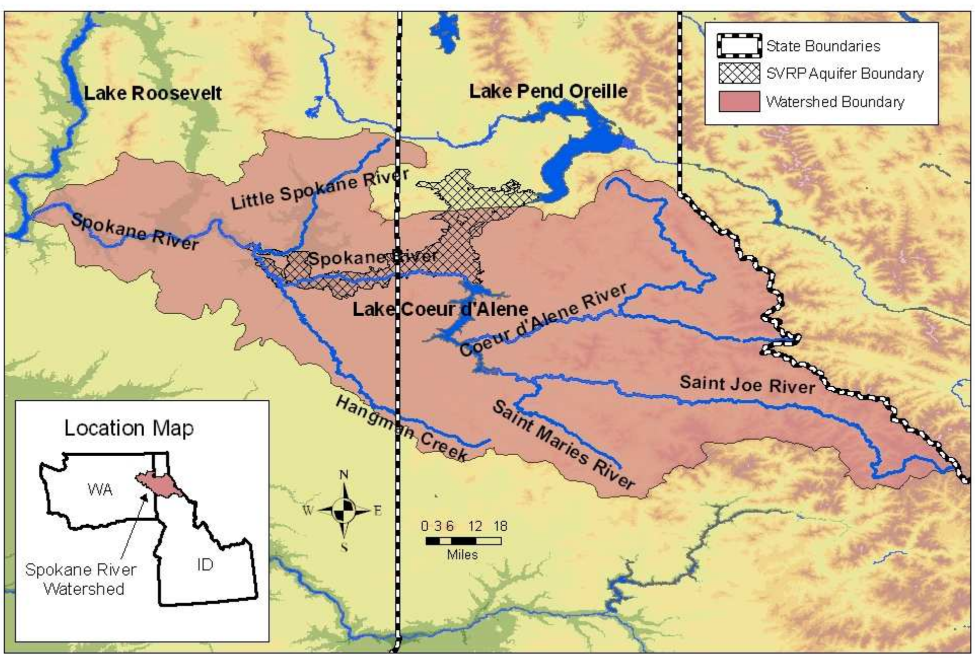


Figure 1. Spokane River Watershed

SCOPE OF WORK

This project represents a comprehensive feasibility analysis of diverting water during high flow periods, injecting it into the SVRP, and letting gravity drain the water back into the Spokane and Little Spokane Rivers for downstream use or flow augmentation on the Columbia River system. The following components will be included in this 18-month study: 1) Needs Assessment, 2) Water Availability Assessment, 3) System Limitations, 4) Target Design Objectives, 5) Alternatives Evaluation, 6) Cost Estimates, 7) Benefits Estimate, and 8) Recommendations and Summary.

Task 1. Needs Assessment

The Needs Assessment will examine factors associated with the purpose, the demand, and the operational criteria such as the time of arrival at several locations along the Columbia River. This section will examine the broader questions surrounding existing and future water requirements in the Columbia Basin and address the economic value to satisfying this constraint. It establishes the basis for the study.

Task 2. Waver Availability Assessment

The Water Availability Assessment will examine potential sources of surface and ground water supplies to determine if either or both are viable for low-flow augmentation. Analyses will be performed on a monthly basis. Both the Pend Oreille and the Spokane/Coeur d'Alene watersheds will be evaluated to determine if they are physically potential sources of surface water. Potential sources of high-flow diversions are the Spokane River and Lake Pend Oreille. Lake Pend Oreille is located on the northeastern boundary of the aquifer. Conversations with Ecology staff in Spokane indicate that winter diversions from the Spokane River are likely feasible. Nevertheless, windows were the flows exceed proposed minimum instream flow criteria will be identified. Figure 2 illustrates the range of high flows that occur during peak runoff events in the Spokane River compared to the low flow trends.

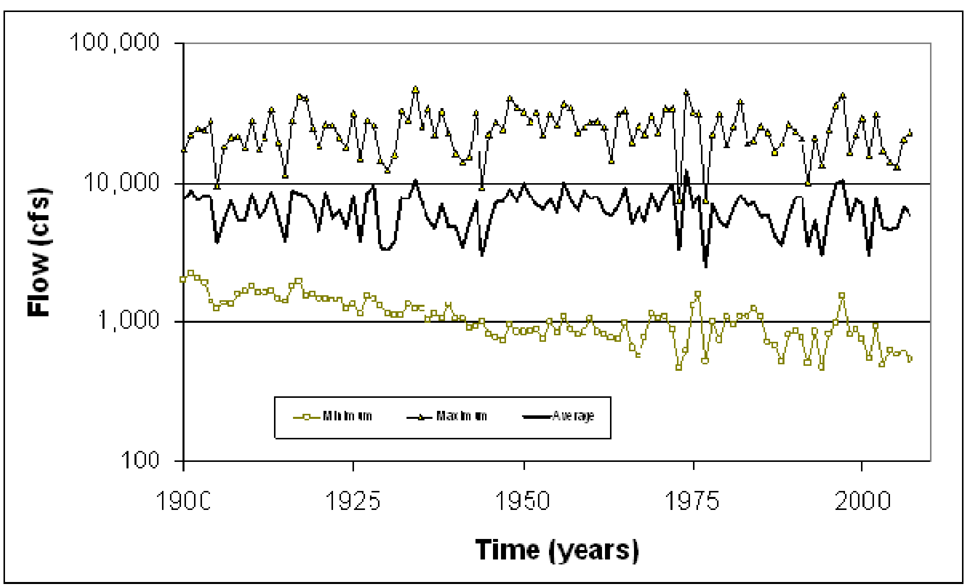
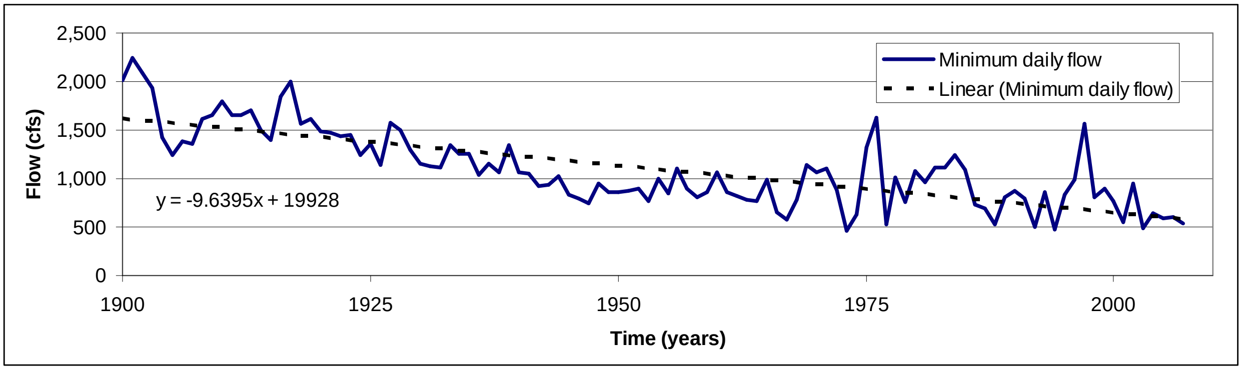


Figure 2. Average monthly stream flows at Spokane River gauge.

As illustrated in Figure 3, summer low flows at the USGS gage near downtown Spokane, WA (USGS gage 12422500) are often less than 1,000 ft^3/s, particularly in the last 40 years. It is this disturbing trend in low flows that raises concerns among water resources agencies, environmental groups, and water right holders. A regression analysis of the minimum annual daily flow data indicates a statistically significantly ($p < 0.0001$) decrease in low flow between 1900 and 2007. While the rate of decline was steepest from 1900 through 1950 (with the slope of the regression line equal to -20.477 $ft^3/s/yr$), the downward trend has still continued since that time (with the slope of 1951-2007 regression line being equal to -3.315 $ft^3/s/yr$). The combined affects of changes in reservoir operations associated with the Post Falls Dam, changes in water use patterns (from irrigation of orchards and row crops to suburban residential uses), increases in municipal pumping as the regions' population has grown and changes in runoff patterns due to climate change (Fu et al, 2007) are creating severe low flow conditions that threaten water users and the environment. Prior to 1940, low flows recorded at the Spokane gage were always greater than 1,000 ft^3/s. However, since 1970, numerous occurrences of flows less than this have been observed with flows less than 600 ft^3/s becoming more frequent. This trend caused the Washington State Department of Ecology (Ecology) to essentially stop issuing new water rights. Consequently, it is important to determine whether high winter-spring flows can be used to augment lower flows.



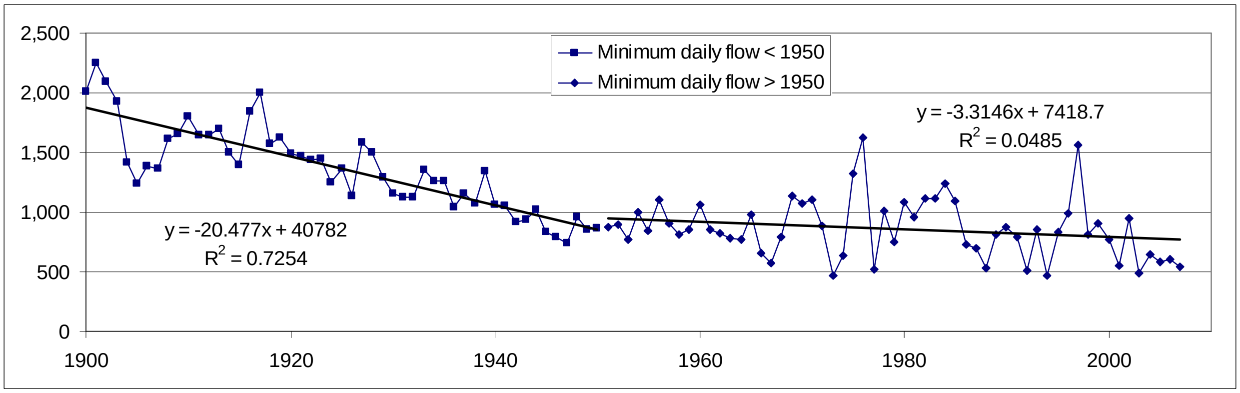


Figure 3. Long-term daily flow trend for Spokane River at Spokane gage

Similarly, a USGS gauge located 1.6 miles downstream of the Lake Pend Oreille Dam indicates the average discharges during the months of December-March based on 76 years of record are 16,300 ft^3/s, 15,500 ft^3/s, 16,400 ft^3/s, and 19,000 ft^3/s, respectively, so high-flow diversions are likely possible. As part of the project, we will explore with IDWR the feasibility of a third-party obtaining an Idaho water right for the appropriate high flow periods determined by the investigation. Recognition by IDWR of the benefits of working collaboratively with Washington on transbasin water issues may facilitate these discussions.

In addition, potential well fields near Lake Pend Oreille and the Spokane River will be investigated. Well water typically requires less treatment before it is discharged and may alleviate any concerns regarding potential aquifer contamination as well as minimize the treatment costs associated with meeting Washington's anti-degradation criteria as well as Idaho's criteria if/when they are different. This chapter will also look at the administrative availability of the water by examining existing agreements including, but not necessarily limited to, the TriParty agreement, Avista, and Columbia Treaty. We will also determine if water rights could be obtained given the interests of existing Idaho, Washington, and Federal Reserved water rights.

<u>Task 3. System Limitations</u>
It is important to identify and examine System Limitations associated with the SVRP serving as an ASR project. This includes investigating aquifer properties such as depth, hydraulic conductivity, and storage potential as well as discharge limitations in the Spokane and Little Spokane Rivers, the possible impact of dams and impoundments, and administrative issues such as closures and future growth in the Coeur d'Alene and Spokane areas. For example, a potential discharge location subjected to excessive injection may result in excessive rise in the groundwater table and thus threatening local basements or quarries. In addition, environmental considerations will be included in the evaluation.

<u>Task 4. Target Design Objective</u>
Preliminary modeling work for 25 ft^3/s infiltration basin and injection well facilities placed at three arbitrarily selected locations demonstrated that there was a potential to increase summer flows at the Spokane River gauge. This is illustrated below in Figure 4. However, no attempt was made to match the value of these increases in terms of potential downstream Columbia Basin demand. This will be an important component of this proposed project. By comparing water needs versus system limitations, a Target Design Objective will be determined. In discussion with Ecology staff, this will represent the preferred design alternative likely based on initial estimates of flow increases versus increases in cost. While this objective will involve a large full-scale project aimed at maximizing water demands, two to four incremental projects (those associated with the difference between the Target Design Objective and those of smaller options) will be identified and examined in equal detail. We will also summarize the investment's incremental costs in terms of both development and operations cost estimates as appropriate as described in the following sections. Just prior to this investigation, we will complete a preliminary or initial feasibility report of the Target Design Objective scenario to discuss with Ecology staff.

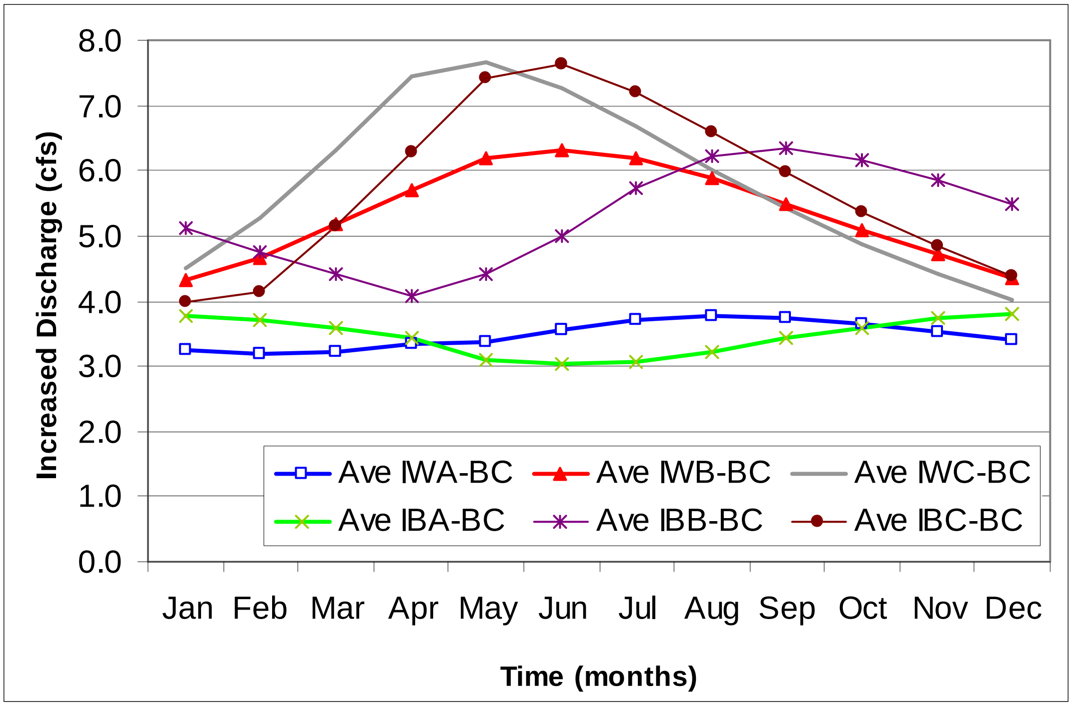


Figure 4. Lag time impacts on average monthly flows at the Spokane River at Spokane gauge

<u>Task 5. Alternative Evaluation</u>

The Alternatives Evaluation section will provide the detailed framework of each potential solution. In all, we envision over 200 spatial variations will be examined although reoccurring patterns may cause alteration of this number. In addition, numerous temporal pumping variations will be included in order to obtain the complete understanding of system response. This will entail examining the water availability from each source, the ability to meet monthly demand projections (hydrologic analysis), and the engineering considerations associated with pipelines, diversion/injection structures, routes, and treatment plants (if necessary). This section will also identify hydrogeologic considerations and positive and negative water quality considerations. The hydrologic analysis will be based on the bi-state transient MODFLOW groundwater model recently developed. The model simulates aquifer levels and streamflow interaction based on the period 1995-2005 which included both wet and dry water years. The model would be modified to examine the effects of well fields and infiltration basins placed at various locations throughout the aquifer on groundwater discharges to the Spokane and Little Spokane Rivers. The lag times between injection and river response for various recharge scenarios would be determined to quantify the water delivered to the stream each month. These flows will be routed downstream to three critical locations along the Columbia River to determine the net benefits to downstream users. It is currently envisioned that the three locations will be the mouth of the Spokane River, Grand Coulee Dam, and the confluence of Lower Crab Creek with the Columbia River. However, these sites can be adjusted during initial meetings with Ecology staff.

The impacts of recharge duration scenarios will also be included to determine the minimum amount of diversion necessary to reach a given flow target. For instance, diverting and injecting flows from December through April at one location may produce the same increase in summer streamflow as February through March at another location. All other things being equal, the shorter duration will likely reduce the operational costs. However, each of these components will be analyzed to determine total project costs.

The difference between injection wells and infiltration basins is the initial time it takes for water to reach the aquifer. In places the SVRP aquifer is several hundreds of feet below the ground surface so water placed in infiltration basins takes 2-4 months to reach the aquifer thereby altering the lag time. Because of the uncertainty associated with current estimates of saturated vertical hydraulic conductivity, sensitivity analyses will be conducted varying the travel time through the unsaturated layer. If infiltration basins are proposed as the preferred alternative, additional recommendations will be made on studies needed to reduce the uncertainty. Likewise, the locations are important because sites close to the river drain fairly rapidly and sites too far away may drain too slowly and therefore may not produce the desired delay into the summer months. Combinations of injection wells and infiltration basins at multiple locations can be used to achieve the appropriate lag and desired increase in summer discharges.

Task 6. Cost Analysis

The feasibility of SVRP aquifer storage will ultimately depend on economics. Therefore, a cost/benefit analysis of each alternative will be conducted. Cost Estimates will be completed for each promising scenario which will include capital costs and operation & maintenance costs. The capital costs are those associated with the water diversion and delivery system, construction of the injection wells and/or infiltration basins, land or right of way costs, treatment costs, and permitting costs. O&M costs include pumping expenses, personnel, and long-term upkeep. Environmental and time factors will also be included in the analysis.

Task 7. Benefits Analysis

Benefit Estimates will be quantified as additional water supply obtained during any month where demands (or projected demands) are not currently being met. Specifically, we will examine the increase in available diversions for withdrawal along the Columbia River. In addition to the direct benefits afforded to the Columbia Basin Project, this project would also have ancillary benefits in that much of the return flows would be run through Avista's hydropower facilities on the lower Spokane River, the flows would augment streamflows in the Spokane River, the cool groundwater inflows would help reduce instream temperatures, and the combination of cooler temperatures and increased flow could help reduce algal blooms in Long Lake. The CE-QUAL-W2 model used by Ecology to help determine phosphorus limits will be run with flow changes to evaluate water quality response. To the extent possible, these benefits will be quantified and included in the study.

Task 8. Recommendations

The final chapter will be the summary and recommendations chapter. It will detail next steps for permitting and engineering design. A risk assessment that includes severity criteria rank investments on the four dimensions of impact on citizens, visibility to the public and Legislature, impact on state operations, and the consequences of doing nothing will be completed. This section will also include any responses to comments provided by the local watershed group as a result of ongoing updates and presentations made to them as part of the project.

TIMELINE and DELIVERABLES

The following project deliverables will be submitted throughout the course of the project:

- Quarterly progress reports,
- Initial feasibility assessment report,
- Draft final report,
- Public presentation to stakeholders,
- Final project report.

The proposed timeline for the eight tasks described in the Scope of Work section is provided below in Figure 5. Assuming a start date of January 1, 2009, the project completion date would be June 30, 2010.

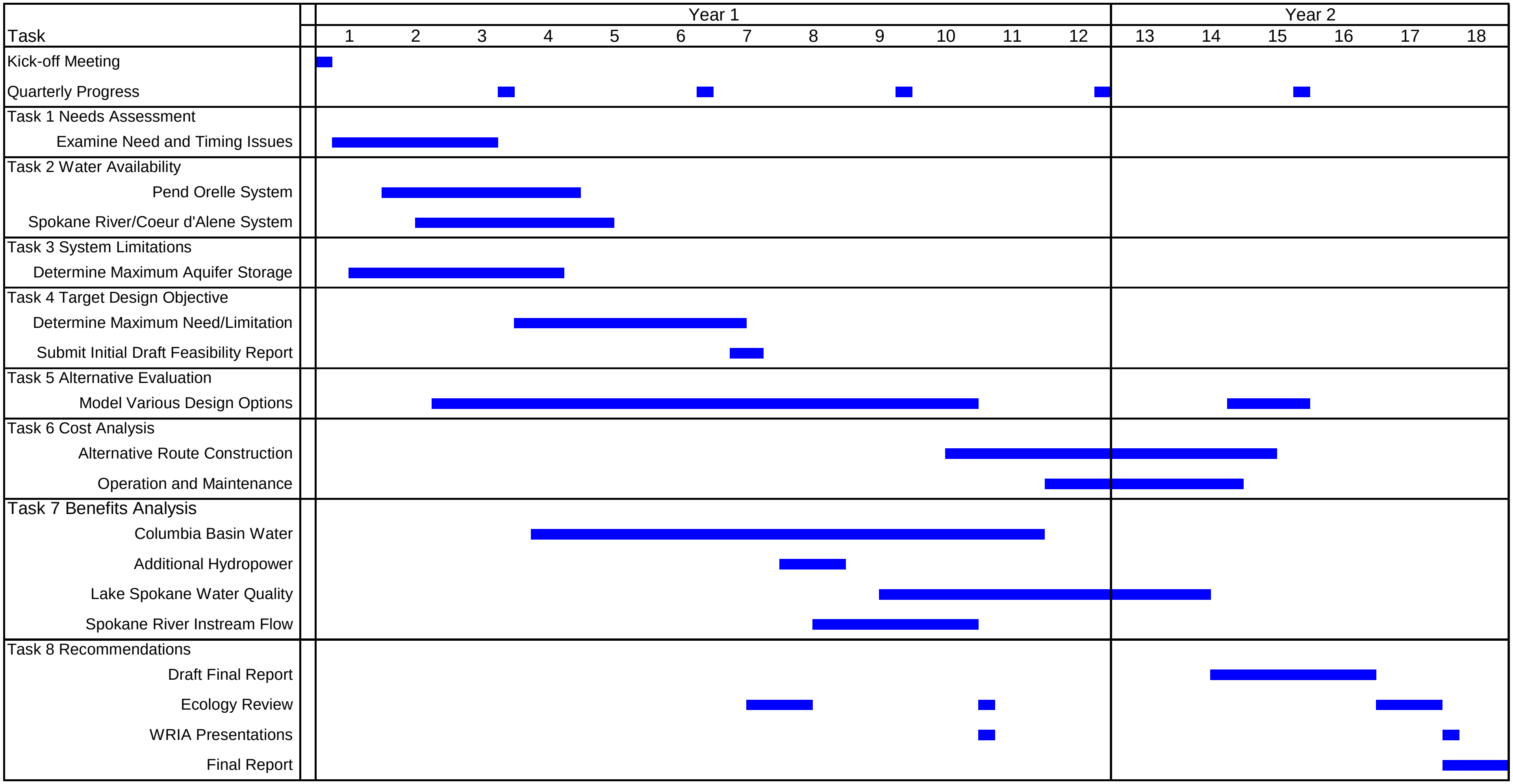


Figure 5. Time line for project completion and milestones